

DISPOSITION OF ECG FINDINGS IN USAF AIRCREW

The following guidelines standardize the aeromedical evaluation and recommendations for 12-lead electrocardiographic (ECG) findings of individuals who must qualify for any class of flying duties. One goal is to streamline the local evaluation and minimize testing that may be repeated at the Aeromedical Consultation Service (ACS). Aircrew with normal or normal variant ECG findings as reviewed by the ECG Library require no further evaluation or follow-up and no waiver action. Additional local studies or an ACS evaluation may be requested by the ECG Library on all individuals with borderline or abnormal ECG findings which are new or not previously evaluated. Originals of all ECGs and any other cardiovascular studies must be forwarded to the ECG library for review and image storage.

If additional studies are performed at the local level and reviewed through the ECG Library as normal or normal variant, no further workup is needed. If the additional studies are reviewed as borderline or abnormal, further evaluation will again be directed through the ECG Library. Unless specified otherwise, borderline and abnormal ECG findings that require additional local workup do not require waiver if the additional workup is reviewed by the ECG Library as acceptable (normal/normal variant). If ACS evaluation or AFMSA/MAJCOM waiver is required for any of the findings, the ECG library will indicate this in its correspondence. **Unless indicated clinically, only the tests requested by the ECG library need to be performed.**

In general, these recommendations are intended to guide the aeromedical workup of the asymptomatic aviator with an electrocardiographic finding. **The aviator who presents with symptoms, signs or findings of potential clinical significance must first be managed as a clinical patient.** Questions regarding ECG findings may be directed to physicians at the ECG Library via telephone at DSN 240-2861 or commercial (210) 536-2861 or via email at usafsam.ecglibrary@brooks.af.mil. Please feel free to contact us. All physicians interpreting studies through the ECG Library are board eligible/certified internists or cardiologists.

The 3 digit number that precedes each ECG diagnosis in the following lists is a databasing code used internally by the ECG Library.

Normal or Normal Variant ECG Findings

The following are considered normal or normal variants in our aviator population. No further evaluation or follow up is needed for these findings.

- 700. Normal ECG
- 002. Sinus bradycardia (40 to 50 beats per minute)
Note: Aeromedically, normal sinus rhythm is defined as 50-100 bpm
- 007. Sinus arrhythmia
- 028. Ectopic atrial rhythm
- 040. Accelerated junctional rhythm
- 080. Supraventricular rhythm at a rate of less than 100 bpm
- 085. Wandering atrial pacer

- 104. Second degree AV block, Mobitz Type I (Wenckebach)
- 121. Incomplete right bundle branch block
- 123. Terminal conduction delay (S wave in the lateral leads ≥ 40 msec)
- 132. Nonspecific intraventricular conduction delay, QRS ≥ 100 but < 120 msec
- 204. ST segment elevation due to early repolarization
- 221. Persistent juvenile T-waves (T wave inversions in V1-3 in an otherwise normal ECG that have been present on all previous ECG's)
- 737. Indeterminate QRS axis
- 743. S₁, S₂, S₃ pattern (S waves in the inferior limb leads)
- 744. S₁, S₂, S₃ pattern with RSR' pattern in V₁ or V₂ with QRS < 120 msec
- 755. R $>$ S in V₁ without other evidence of right ventricular hypertrophy
- 764. RSR' pattern in V₁ or V₂ with QRS < 120 msec

Abnormal or Possibly Abnormal ECG Findings

Marked Sinus Bradycardia: Marked sinus bradycardia is most often the result of athletic conditioning with increased vagal tone and is not associated with an adverse prognosis. Past evaluation of this finding by the ECG Library has consistently failed to uncover evidence of sinus node dysfunction. Therefore, further evaluation of this finding is not required, unless requested in an individual case by the ECG Library physician.

- A02. Marked sinus bradycardia (< 40 bpm)

Sinus Tachycardia: The following ECG finding may be transient and due to anxiety, fever, pain, etc. It may occasionally be an indicator of underlying heart disease or a metabolic abnormality. If this tachycardia is noted on an ECG, a repeat ECG should be obtained. If this is a persistent finding on the repeat ECG, thyroid function studies and CBC should be obtained while the aviator remains on flying status (no DNIF). If these studies are unremarkable and sinus tachycardia is a persistent finding, a Holter monitor should be obtained and further evaluation pursued as clinically indicated and/or requested by the ECG Library.

- 001. Sinus tachycardia (resting heart rate > 100 bpm)

Short PR Interval:

Short PR interval (PR < 120 msec) may be a normal variant but is occasionally evidence for a bypass tract, even without an accompanying delta wave. Before diagnosing short PR interval, one must assure that it is truly a sinus rhythm with sinus origin P waves, rather than ectopic atrial or other rhythm. For a PR interval between 100 and 120 msec, it is most likely a normal variant, but could represent a bypass tract. For these cases, a thorough history should be obtained locally with specific questions aimed at the detection of tachyarrhythmias, to include palpitations, rapid heart beat sensations, lightheadedness or syncope. If the history is unremarkable with no suggestion of a possible tachyarrhythmia, then no further evaluation is indicated and the finding should be considered a normal variant. For a PR interval less than 100 msec, the possibility of a bypass tract is much greater and the aviator should be placed on DNIF status and an ACS evaluation performed, if ECG Library review confirms the finding.

029. Short PR interval (PR interval < 120 msec in all leads)

Wolff-Parkinson-White:

Wolff-Parkinson-White or any other suspected bypass tract condition requires ACS evaluation. The aviator/aircrew should be placed DNIF pending ACS evaluation. The primary physician should insure that the aviator is clinically stable prior to arranging an ACS evaluation.

704. Wolff-Parkinson-White pattern
705. Lown-Ganong-Levine pattern

Prolonged QT Interval:

Perform a repeat fasting ECG and submit both ECGs to the ECG Library with a list of any prescription or over-the-counter medications and supplements used. Further guidance will follow ECG Library review of this information.

215. Prolonged QT defined as a QTc >450 msec in males or >460 msec in females.

Atrial Enlargement/Abnormality:

The following are nonspecific as isolated ECG findings. Depending on the magnitude of the findings, an echocardiogram may be requested at the discretion of the interpreting physician at the ECG Library.

500. Left atrial enlargement
501. Right atrial enlargement
503. Biatrial enlargement

Ventricular Hypertrophy: An echocardiogram is required for evaluation of these ECG findings, if new or not previously evaluated. If the echocardiogram is normal or normal variant by ECG Library review, no further workup is necessary. Since the specificity of these findings on ECG is poor, the aviator does not need to be DNIF pending our interpretation of the echocardiogram. For any left ventricular hypertrophy also provide a detailed exercise history for the past 6-12 months.

720. Left ventricular hypertrophy by voltage criteria and ST segment abnormalities
721. Right ventricular hypertrophy
727. Biventricular hypertrophy
729. Left ventricular hypertrophy by voltage alone (sum of the S wave voltage in V₁ or V₂ plus the R wave voltage in V₅ or V₆ > 55 millivolts for individuals 35 years old or younger or > 45 millivolts for individuals older than 35 years of age).

First Degree AV Block:

First degree AV block is most often the result of athletic conditioning with increased vagal tone. This finding is common and not associated with an adverse prognosis. Past evaluation of this finding by the ECG Library has consistently failed to uncover evidence of conduction system disease. Therefore, evaluation of this finding is only required if requested by the interpreting physician at the ECG Library, typically for very prolonged PR interval, and especially when a new finding.

100. First degree AV block. (PR interval ≥ 220 msec.)

Second and Third Degree AV Block:

The following abnormalities, if confirmed by the ECG Library or local consultant, are disqualifying for flying duties and waiver is not recommended. ACS evaluation is not required. Local medical evaluation and management is mandatory. Mobitz Type I second degree AV block (Wenckebach block) is considered a normal variant and is listed as such above.

- 105. Second degree AV block, Mobitz Type II
- 108. Complete heart block. This must be differentiated from A-V dissociation due to sinus bradycardia with a competing junctional rhythm, which may be a normal variant finding.

Right Bundle Branch Block:

This recommendation includes new complete right bundle branch block or complete right bundle branch block that has progressed from previous incomplete right bundle branch block. An echocardiogram is required for evaluation. If a previous echocardiogram is on file at the ACS, it may be acceptable per judgment of the ECG Library physician. The aviator does not need to be DNIF during this evaluation. Incomplete right bundle branch block alone is a normal variant and does not require evaluation.

- 120. Right bundle branch block with normal QRS axis. Bifascicular block (RBBB plus left anterior/posterior hemiblock) is treated like isolated left anterior/posterior hemiblock, see below.

Left Bundle Branch Block:

Left bundle branch block requires ACS evaluation. The aviator/aircrew should be placed DNIF pending ACS evaluation. The primary physician should insure that the aviator is clinically stable prior to arranging an ACS evaluation.

- 124. Left bundle branch block

Hemiblocks and Left Axis Deviation:

Hemiblocks and left axis deviation may be markers of underlying organic heart disease, particularly coronary artery disease. But they may also be present without underlying organic heart disease and may then be considered acceptable findings. Left axis deviation may be associated with left ventricular hypertrophy, coronary artery disease and increasing age. Required evaluation depends on the age of the aviator/aircrew. For age less than or equal to 35 years, remain on flying status (no DNIF), local echocardiogram (if a previous screening echocardiogram is on file at the ACS, it may be acceptable per judgment of the ECG Library physician. For age greater than 35 years, remain on flying status (no DNIF), local echocardiogram and local treadmill.

The diagnostic criteria and evaluation of hemiblocks and left axis deviation are as follows:

- 126. Left anterior hemiblock (LAH):
Displacement of the mean QRS axis in the frontal plane to between -45° and -90° , and
A qR complex in leads I and AVL, an rS complex in leads II, III and AVF, and
normal or only slightly prolonged QRS duration.
- 128. Left posterior hemiblock (LPH):
Displacement of the mean QRS axis in the frontal plane to between $+120^{\circ}$ and $+180^{\circ}$, and
An rS complex in leads I and AVL, a qR complex in leads II, III and AVF, and
normal or only slightly prolonged QRS duration
- 735. Left axis deviation (LAD):
QRS axis -30° or more negative without full criteria for LAH as above.

Right Axis Deviation:

Right axis deviation (RAD) is defined as a QRS axis $+120^\circ$ or more positive without criteria for left posterior hemiblock above. If RAD is seen as an initial finding in an individual 35 years old or younger, no evaluation is typically required. If RAD is initially identified in an individual over 35 years old, the required evaluation is an echocardiogram. The aviator may remain on flying status (no DNIF) during the evaluation.

736. Right axis deviation (RAD)

Supraventricular and Ventricular Ectopy and Pairing: The following rhythm disturbances should be investigated with a Holter monitor. The aviator may remain on flying status pending this study (no DNIF). If the Holter monitor is acceptable by ECG Library review, per **Holter Monitor Findings** section below, no further evaluation is required. In summary, Holter monitor is required for paired premature beats and for two or more premature beats on a single page of ECG paper, 12- lead or rhythm strip, regardless of the age of the aviator/aircrew. Holter monitor is required for one isolated ventricular premature beat on a single page of ECG paper, 12- lead or rhythm strip, only if the aviator/aircrew is age 35 years or older. Age younger than 35 years requires no evaluation for one ventricular premature beat on a single page of ECG paper, 12- lead or rhythm strip.

Holter monitor is required for the following:

- 023. Premature atrial beat, two or more on a single page of ECG paper, 12- lead or rhythm strip
- 043. Premature junctional beat, two or more on a single page of ECG paper, 12- lead or rhythm strip
- 083. Premature supraventricular beat, two or more on a single page of ECG paper, 12- lead/rhythm strip
- 063. Premature ventricular beat (PVC),
 - a) Age less than or equal to 35 years, with two or more PVCs on a single page of ECG paper
 - b) Age greater than 35 years, with one or more PVCs on a single page of ECG paper
- 032. Paired atrial premature beats, one or more pairs on a single page of ECG paper
- 046. Paired junctional premature beats, one or more pairs on a single page of ECG paper
- 072. Paired ventricular premature beats, one or more pairs on a single page of ECG paper

Supraventricular Tachycardias:

Any individual with a documented supraventricular tachycardia (three or more supraventricular premature beats in a row at a rate exceeding 100 bpm) should be placed DNIF pending further review. One 24 hour Holter monitor should be obtained. If the finding is on a Holter, then that Holter will suffice and repeat Holter is not warranted unless requested by the ECG Library physician. If the evaluation reveals only one isolated run of SVT between 3 and 10 beats in length, no further testing is typically required. Aeromedical disposition will be recommended after these studies are forwarded to the ACS for review and confirmation. If the Holter shows more than one run of SVT, or if a single run is more than 10 beats in length, ACS evaluation is required; no further local evaluation is needed prior to ACS evaluation unless indicated by the clinical situation or requested by the ECG Library physician.

- 021. Atrial tachycardia
- 026. Atrial fibrillation
- 027. Atrial flutter
- 036. Multifocal atrial tachycardia (MAT)
- 041. Junctional tachycardia (> 100 bpm)

081. Supraventricular tachycardia

Ventricular Tachycardia: An aviator/aircrew with ventricular tachycardia should be DNIF. He should undergo internal medicine evaluation; if there is evidence of organic heart disease or if the aviator has associated hemodynamic symptoms, he should be treated as needed by his local physician. Otherwise, one 24 hour Holter monitor is required. ACS evaluation is required for waiver consideration of isolated or recurrent asymptomatic nonsustained ventricular tachycardia.

061. Ventricular tachycardia (three or more ventricular beats in a row at a rate > 100 bpm)

Ventricular Fibrillation and Ventricular Flutter: The following abnormalities are disqualifying for continued flying duties. Waiver is not recommended, and ACS evaluation is not required.

066. Ventricular fibrillation

067. Ventricular flutter

Findings Suggestive of Myocardial Infarction:

These findings are disqualifying for continued flying duties. The individual should have an internal medicine or cardiology evaluation to insure that he is clinically stable. If a true myocardial infarction is confirmed, this is disqualifying for flying duties without waiver. If the subject is stable and the diagnosis is in question, he should undergo a complete ACS evaluation.

All 600 series codes. Myocardial infarction

The aviator may remain on flying status during evaluation of the following more nonspecific findings:

739. Non-diagnostic Q waves. No further evaluation is required unless directed by the ECG Library.
759. Poor R wave progression. This finding may be due to poor chest lead placement or can be a normal variant. It can also be seen in myocardial infarction. Evaluation consists of repeat ECG with attention to chest lead placement and other testing as directed by the ECG Library. Echocardiogram may be requested to rule out wall motion abnormalities.

18. ST Segment and T Wave Abnormalities:

The following diagnoses may be normal variants, or may be findings associated with myocardial ischemia or cardiomyopathy. The nonfasting state may cause nonspecific ST-T wave changes on ECG. If these findings represent a serial change and persist after repeat fasting ECG, a treadmill exercise tolerance test should be performed on aviators aged 35 or older. For aviators younger than 35 years, an echocardiogram should be performed. If a previous screening echocardiogram is on file at the ACS, it may be acceptable per judgment of the ECG Library physician. Since mild ST segment and T wave abnormalities are not very specific, the aviator does not need to be DNIF during this evaluation. However, judgment should be exercised in aviators with more than mild changes or compelling coronary risks.

200. Low T waves less than 2 mm in chest leads V3-V6 or less than 0.5 mm in limb leads I and II.
201. Nonspecific T wave abnormalities
203. Nonspecific ST segment depression

19. Cardiac Inflammation (Pericarditis and Myocarditis):

If pericarditis or myocarditis is present, the aviator should be placed DNIF and should be treated as indicated by his clinical condition. Typical cases of self-limited, uncomplicated viral or idiopathic pericarditis require only local aeromedical evaluation. This should be performed a minimum of two months after the symptoms have completely resolved and a minimum of one month off all anti-inflammatory medications. Aeromedical evaluation includes an echocardiogram, 24-hour Holter monitor and aeromedical summary. The aeromedical evaluation and all cardiac studies done clinically during the acute phase of the illness must be reviewed by the ECG library. If our review is aeromedically acceptable, permanent waiver without ACS evaluation or required aeromedical reevaluation may be recommended. The aviator should be DNIF until after our review/recommendations and action by the appropriate waiver authority. Atypical or complicated cases require ACS evaluation. Myocarditis requires ACS evaluation before a waiver can be recommended.

706. Compatible with pericarditis

707. Compatible with myocarditis

Miscellaneous

Treadmill Test Results:

In order to insure a consistent interpretation of all studies and to attain the highest sensitivity, the following criteria were established for classifying treadmill exercise tolerance test results. The ST segment depression will be read at 80 msec after the J point irrespective of ST segment slope. The PQ segment will be used as the baseline. Tests showing less than 0.5 mm of ST segment depression are considered normal. Tests showing 0.5 to 0.9 mm of ST segment depression are considered borderline. Tests showing 1 mm or more of ST segment depression are abnormal. Any studies considered to be borderline or abnormal will require an ACS evaluation.

Treadmill testing may also be suggestive of organic heart disease due to findings other than ST segment depression. These may include exercise-induced chest discomfort, hypotensive blood pressure response to exercise, chronotropic incompetence with decreasing heart rate at peak exercise or exercise-induced dysrhythmias. Exercise-induced dysrhythmias should be treated as previously described.

The treadmill test should be performed in the fasting state. Baseline ECGs should be obtained supine, standing, and after hyperventilation. If ST segment depression is present on any baseline ECG, 1 mm of additional ST segment depression beyond the baseline ST segment will be required to be considered abnormal. The **raw unprocessed tracings and interpreted report** must be forwarded to the ECG Library for review, as with all cardiovascular studies. Computer synthesized ECG tracings may average baseline motion artifact and give a false positive reading of ST segment depression.

Holter Monitor Findings:

The Holter monitor study is generally performed to evaluate rhythm or conduction disturbances found on physical exam or 12-lead ECG. If a finding is confirmed on Holter monitoring (such as rare or occasional PVCs or PACs) but no other additional findings are seen, then no additional studies are generally required. The recommendation for continued flying or “DNIFing” pending the results of the Holter is covered in prior sections, and is based on the abnormality being evaluated.

If isolated ectopic beats are found to be frequent ($> 1\%$ and $\leq 10\%$ of all beats), an echocardiogram and treadmill test should be performed. The aviator should remain on flying status pending results.

If ectopic beats are very frequent ($>10\%$ of all beats), the aviator should be placed DNIF pending an ACS evaluation. Additional local testing is not needed unless otherwise clinically/aeromedically indicated.

If 1-10 ectopic pairs are seen on 24 hours Holter monitoring, a treadmill test and echocardiogram should be performed. If ectopic pairs exceed 10 pairs for 24 hours of monitoring, the aviator should be DNIF pending an ACS evaluation; additional local testing is not needed unless otherwise clinically/aeromedically indicated.

The **interpreted report summary, representative tracings, and patient diary** must be forwarded to the ECG Library for review.

Echocardiograms:

The echocardiogram should be recorded at **STANDARD PLAY** (SP - 2 hour format). It must include M-mode, 2-dimensional and Doppler studies. Ensure that patient identification and the test date are printed on the VHS tape label. A **VHS tape copy of the study and the interpreted report summary** must be forwarded to the ECG Library for review. If CD is forwarded, then the disc must include a copy of the viewing program along with the cardiac imaging.